Medium Modification of Heavy Flavor Production Measured by PHENIX in Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV

Alan Dion of STONY BROOK
STATE UNIVERSITY OF NEW YORK

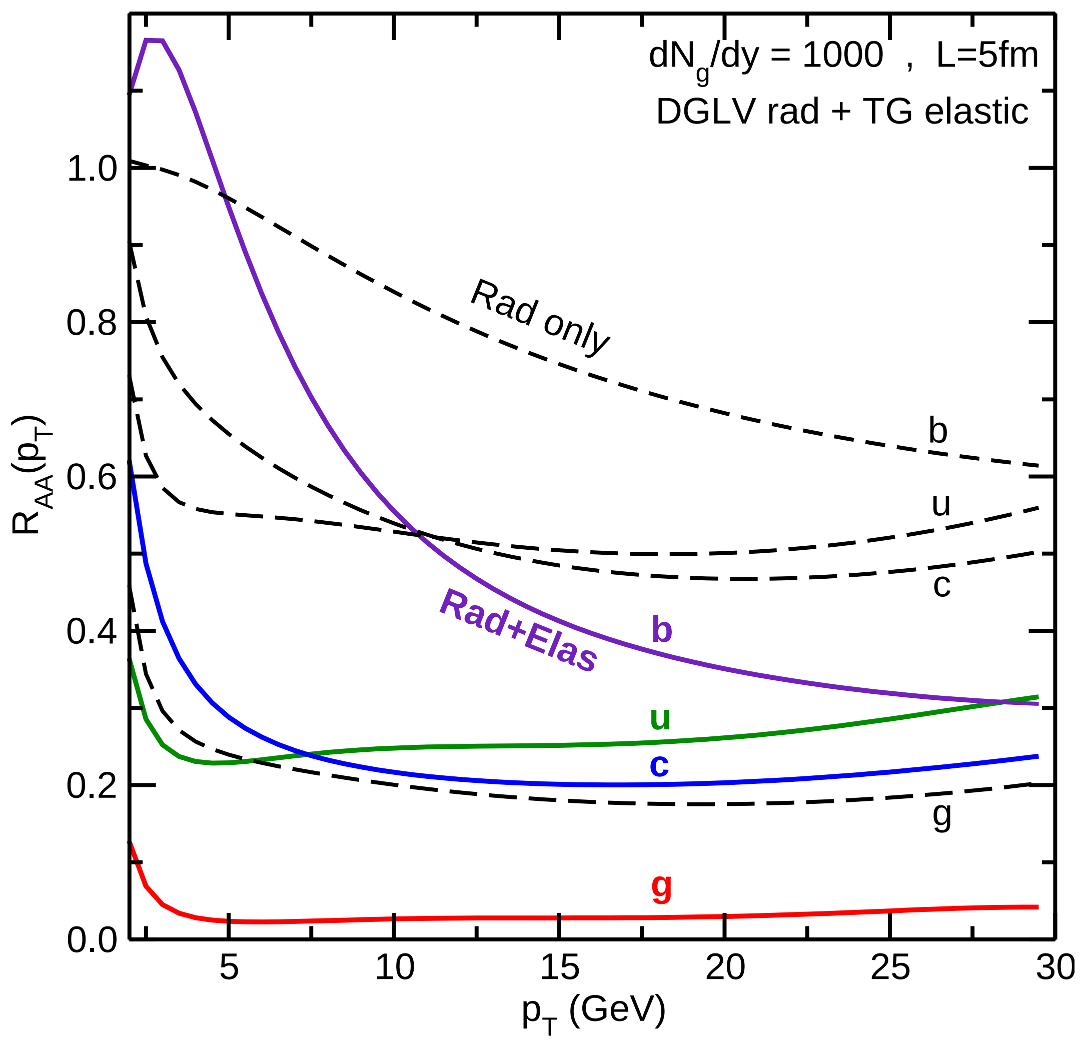
for the PHENIX collaboration

Outline

- Motivation
- Experimental Approach to measuring heavy flavor production
- Extraction of the heavy flavor signal
- Heavy quark yields
- Nuclear Modification Factor
- Summary

Why is Heavy Flavor Interesting?

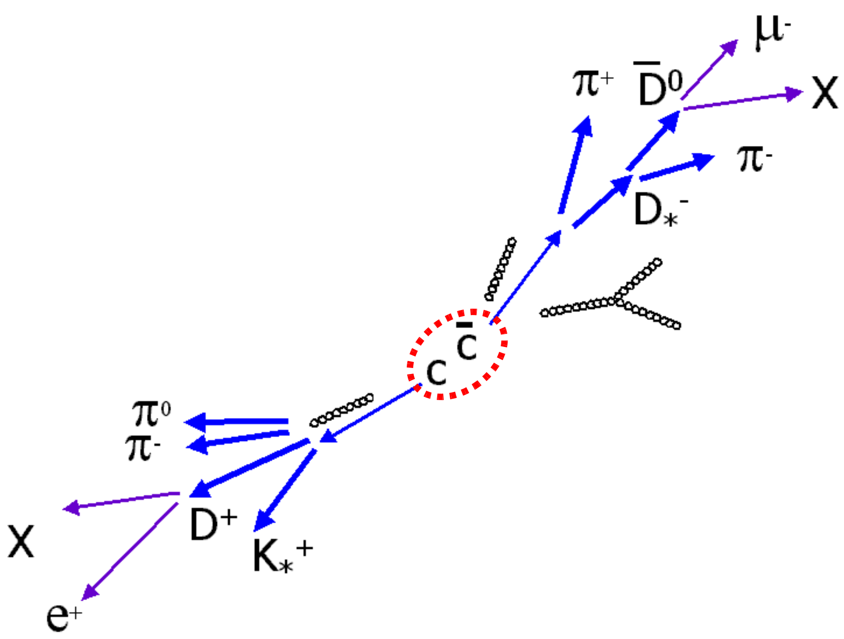
- Heavy quark production can be treated with pQCD due to large momentum transfer required. It has been shown that the total charm yield at RHIC scales as the number of binary collisions.
- The suppression of heavy quarks is sensitive to the initial temperature and gluon density.
- The open charm spectra serves as a baseline for the J/Ψ
- Heavy quark anisotropies provide information about thermalization.

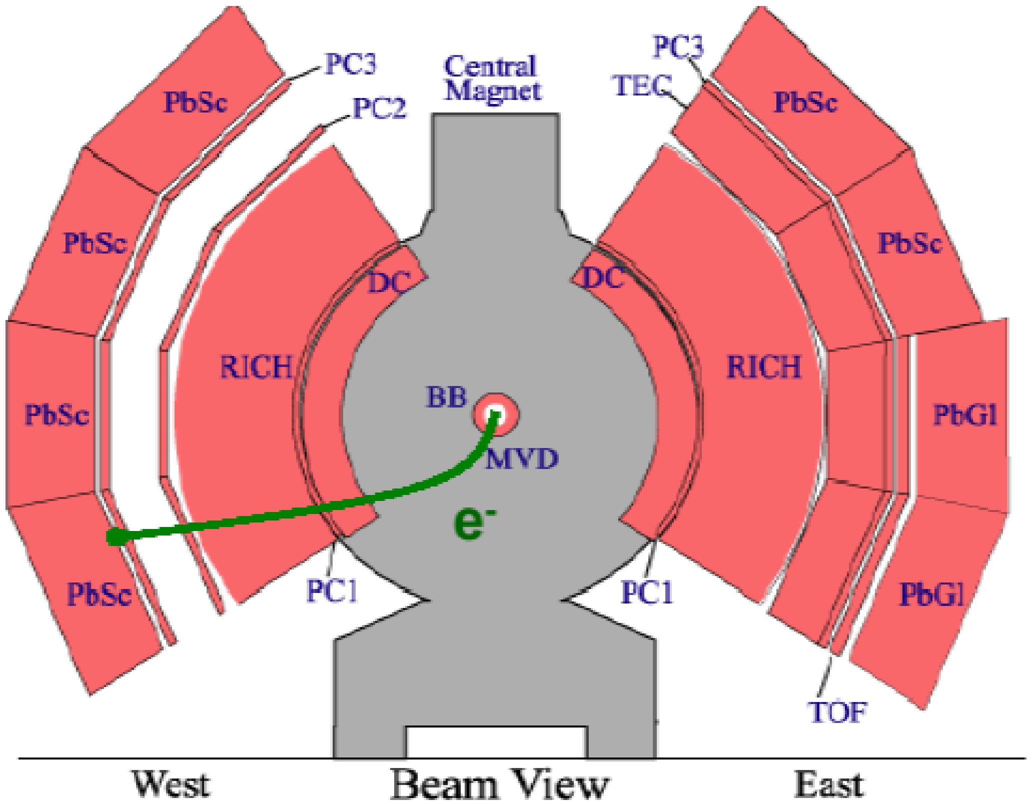


Predictions for partonic-level R_{AA}

M. Djordjevic, M. Gyulassy, W. Horowitz, S. Wicks
nucl-theory/0512076

Experimental Approach to Open Charm





- PHENIX has measured D and B through electron and muon decays. This talk focuses on the electron measurement.

- Tracking:

  Drift Chamber

- Electron Identification:

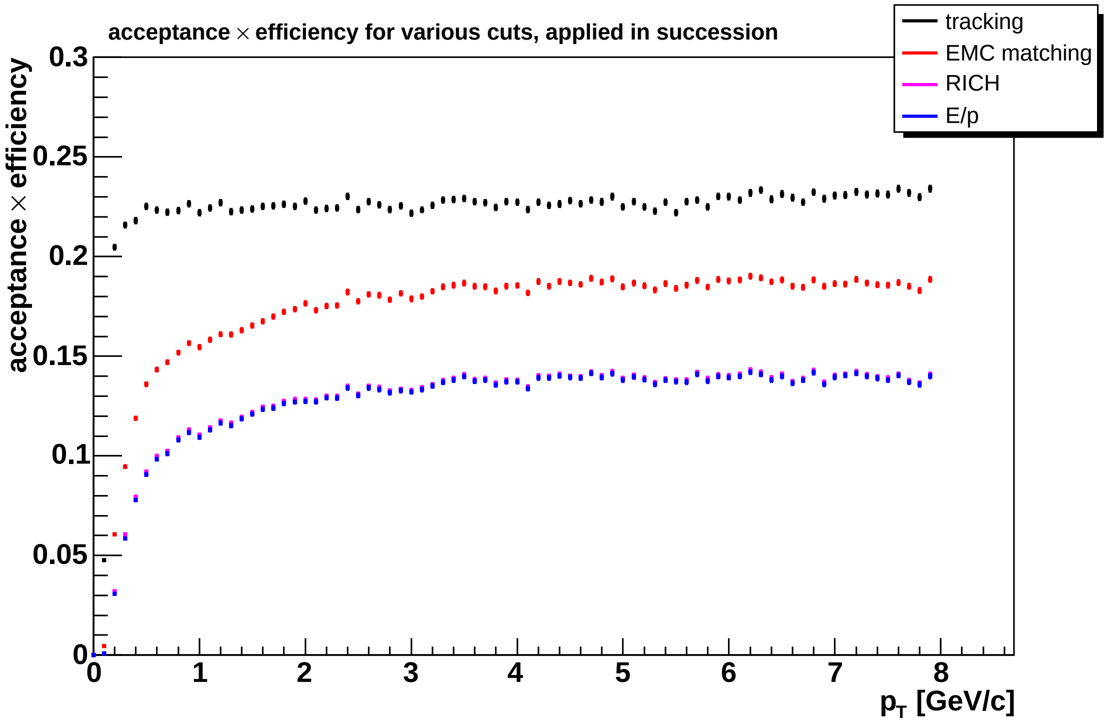
  Ring-Imaging Cherenkov Detector

  PbSc and PbSc electromagnetic calorimeters

  E/p distribution

Acceptance and Efficiency Corrections

- The PHENIX detector covers π radians in azimuth and about 1 unit of pseudorapidity, for a total ideal geometrical coverage of about 35%
- In addition, we must correct for dead area and detector efficiency. To this end, single electrons were simulated and used as the source for a GEANT-based detector response Monte Carlo of PHENIX.
- Occupancy corrections: The efficiency from occupancy effects ranges from 79.1% for the 0-10% centrality bin, to 96.5% for the 60-93% bin.



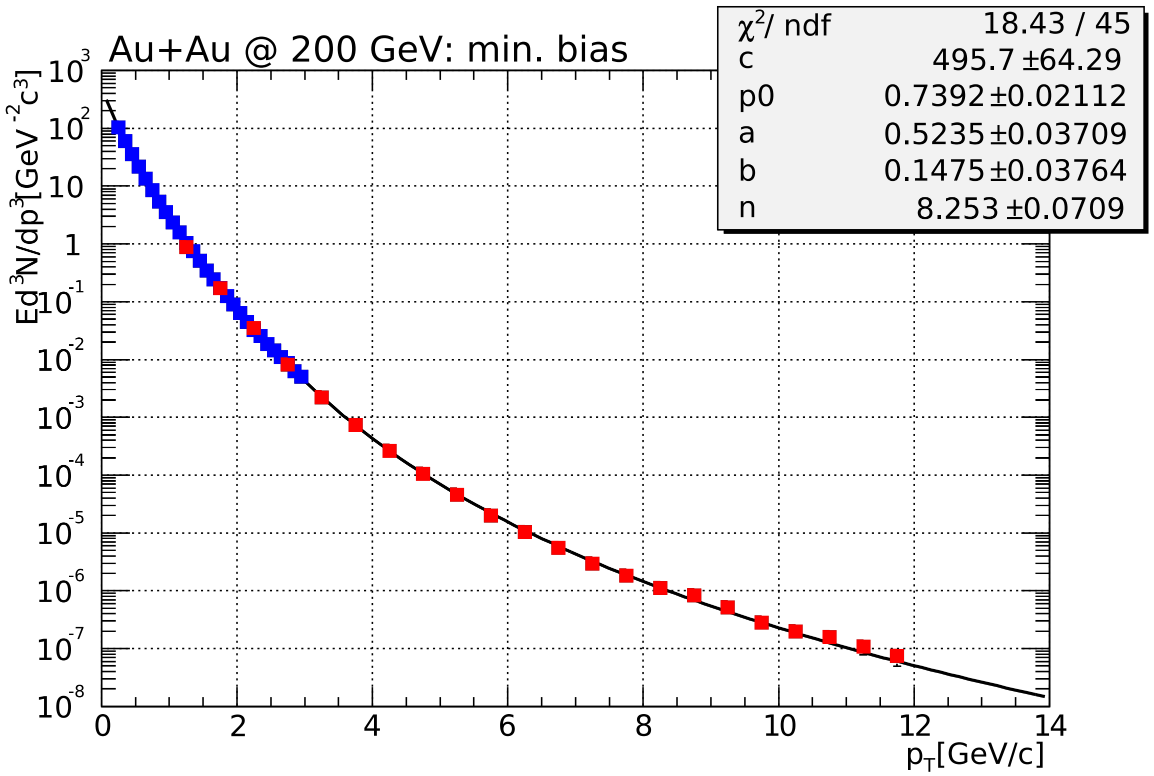
acceptance $\times$ efficiency after making cuts based on tracking and electron identification, as well as some fiducial cuts to protect against effects from dead area.

Extraction of Heavy Flavor Signal

What are the sources of electrons in PHENIX?

- Dalitz decay: $\pi^0, \eta, \eta', \omega, \phi \longrightarrow \gamma e^+ e^-$
- Photon conversions: $\gamma \longrightarrow e^+ e^-$ in material (mainly beam pipe)
- K_{e3} : $K^\pm \longrightarrow \pi^0 e^\pm \nu_e$
- Vector meson decays: $\rho, \omega, \phi \longrightarrow e^+ e^-$
- Heavy flavor decays

Source Estimation from Electron Cocktail

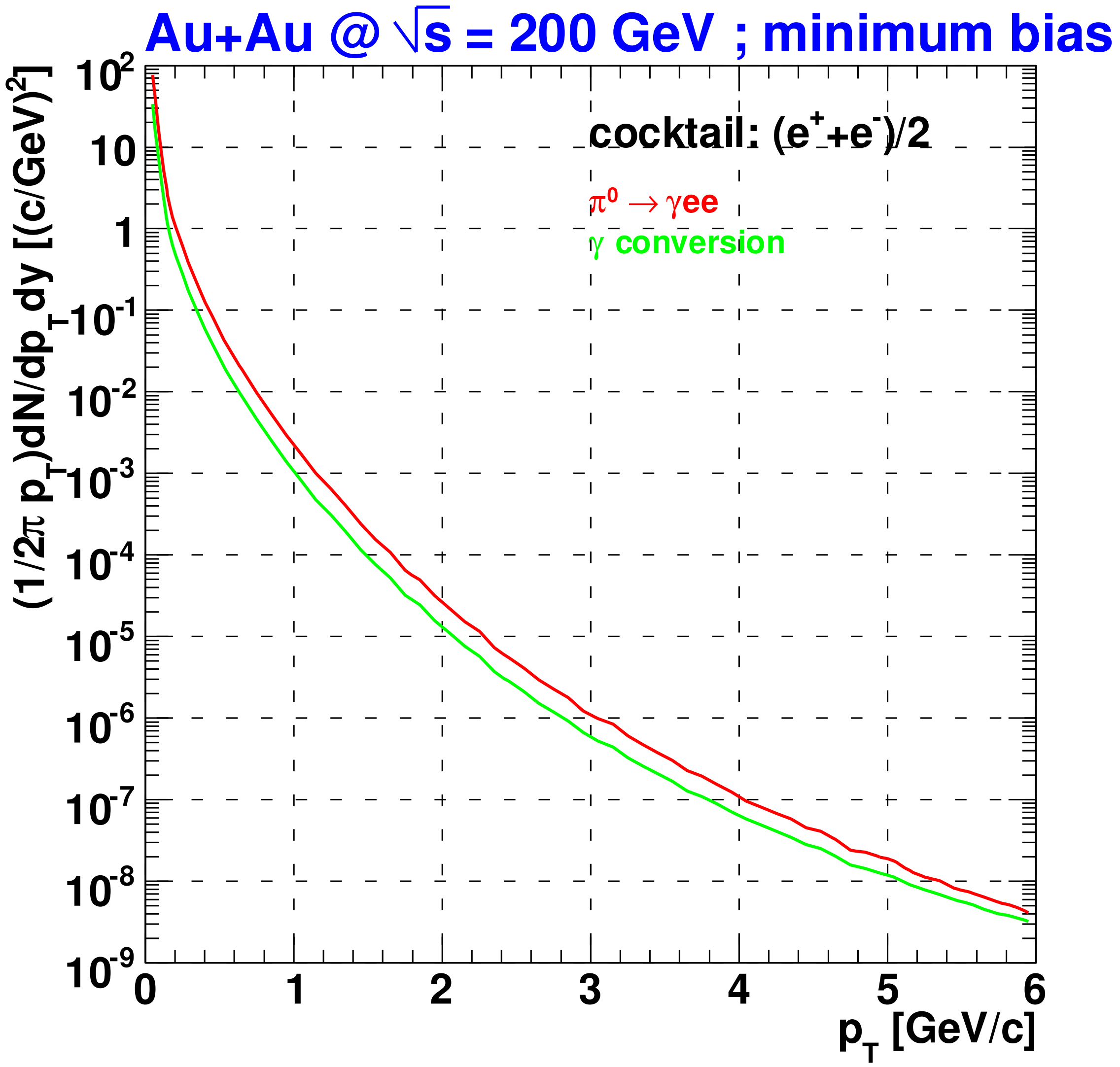


measured pion spectra as input

$$E\frac{d^3\sigma}{d^3p_T} = \frac{c}{[e^{-ap_T-bp_T{}^2} + \frac{p_T}{p_0}]^n}$$

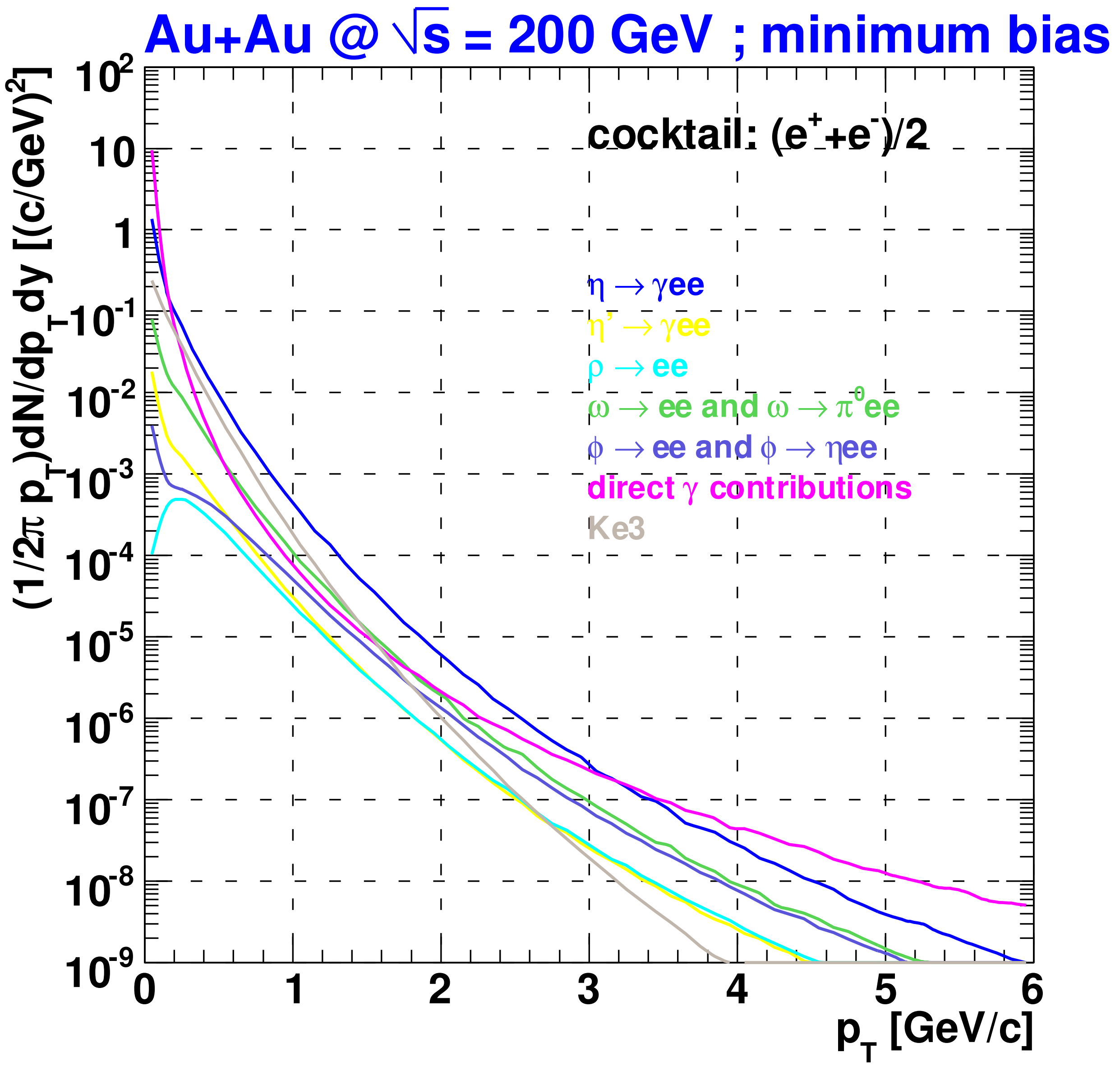
→ Decay generator and detector response Monte Carlo

↓

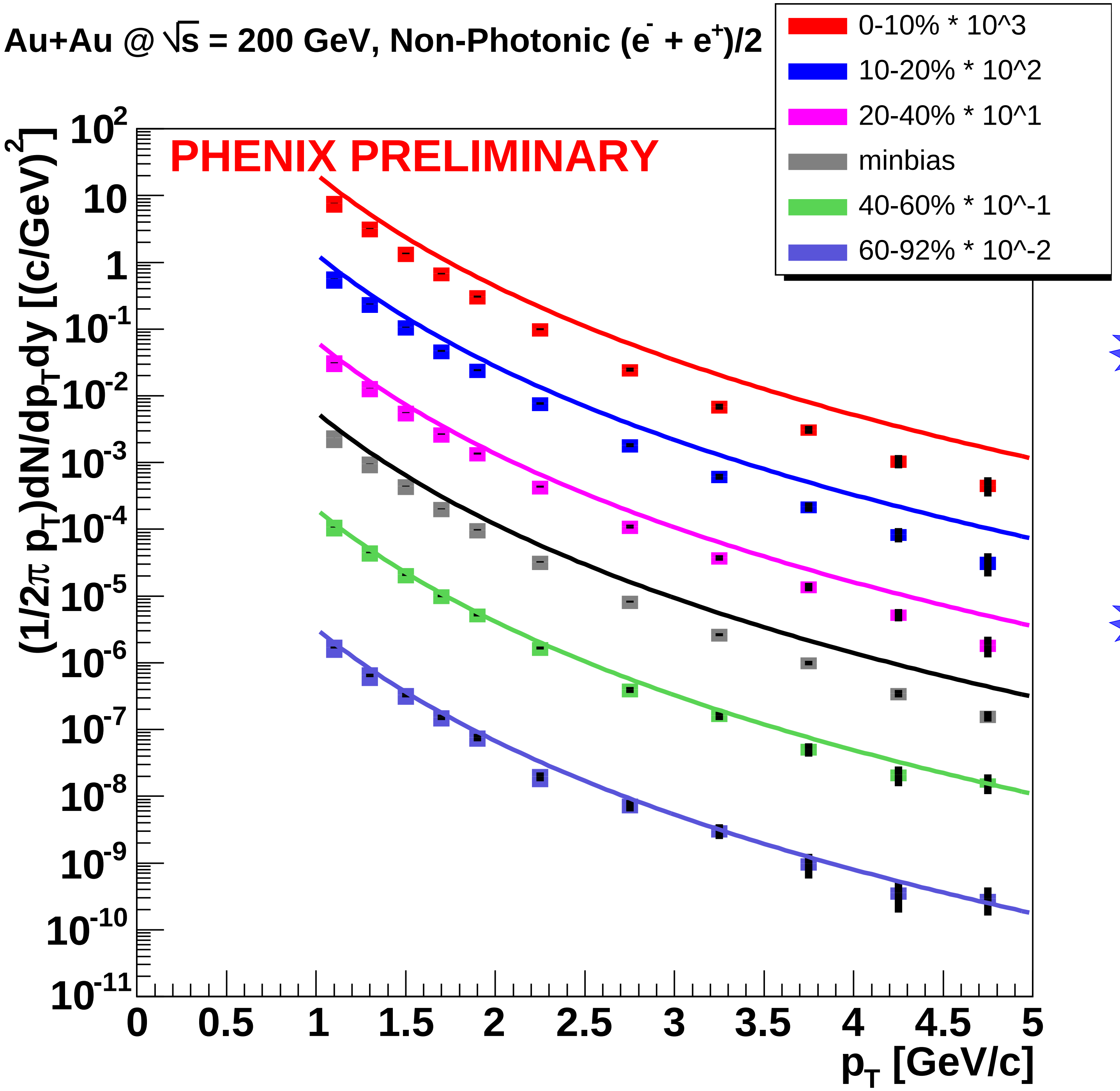


Source Estimation from Electron Cocktail

- To estimate the contribution from other mesons, we use m_T scaling and known particle ratio yields
- For K_{e3} and conversions from direct photons, a full Monte Carlo is done based on PHENIX measurements.

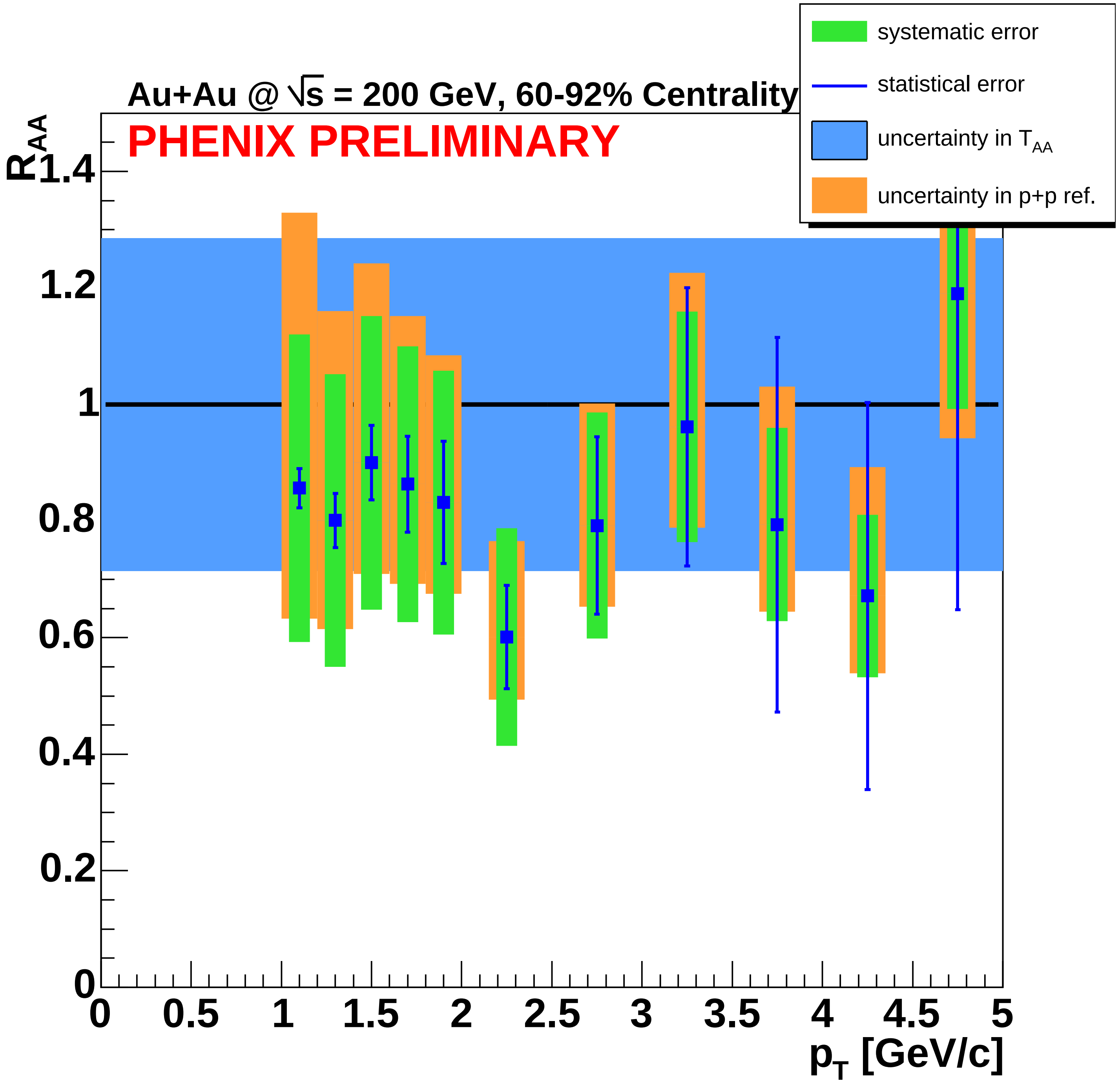


Non-photonic Electron Spectrum



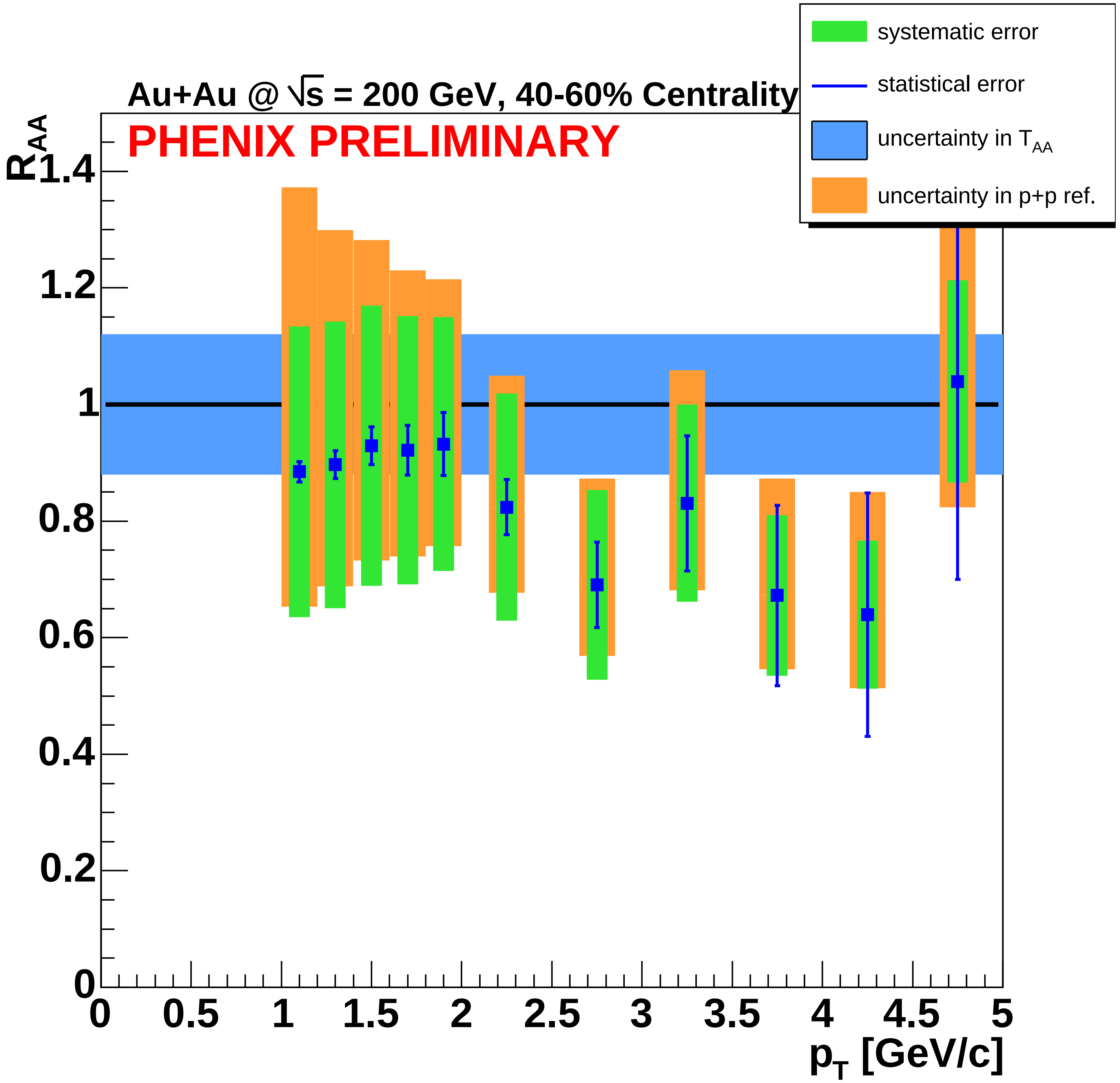
- The non-photonic spectra are obtained by subtracting the cocktail from the inclusive spectra for each centrality bin.
- The solid curves are fits to the non-photonic spectra from p+p collisions.

R_{AA}



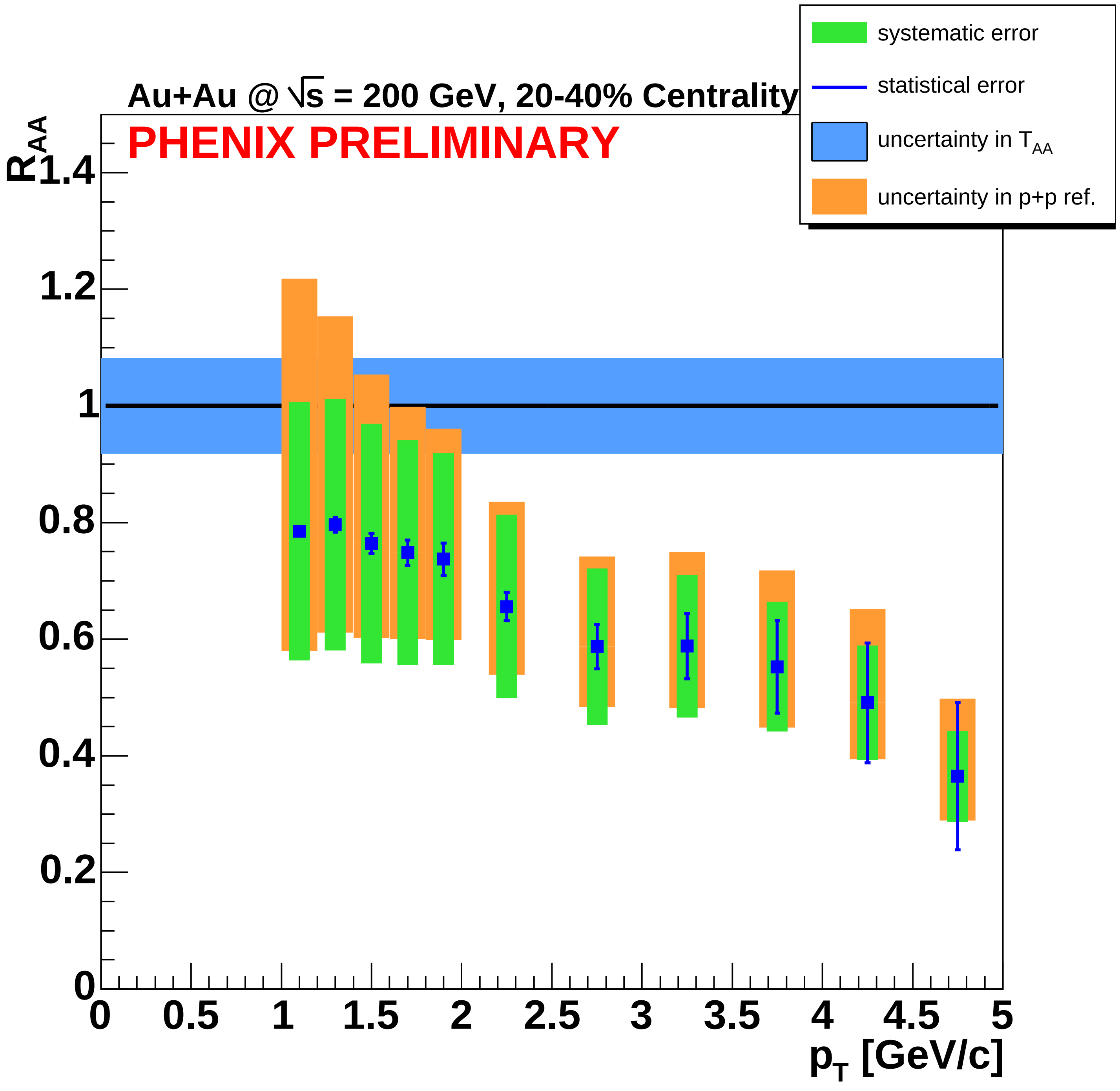
$$R_{AA} \equiv \frac{dN_{AA}}{\langle T_{AA} \rangle dN_{pp}}$$

R_{AA}



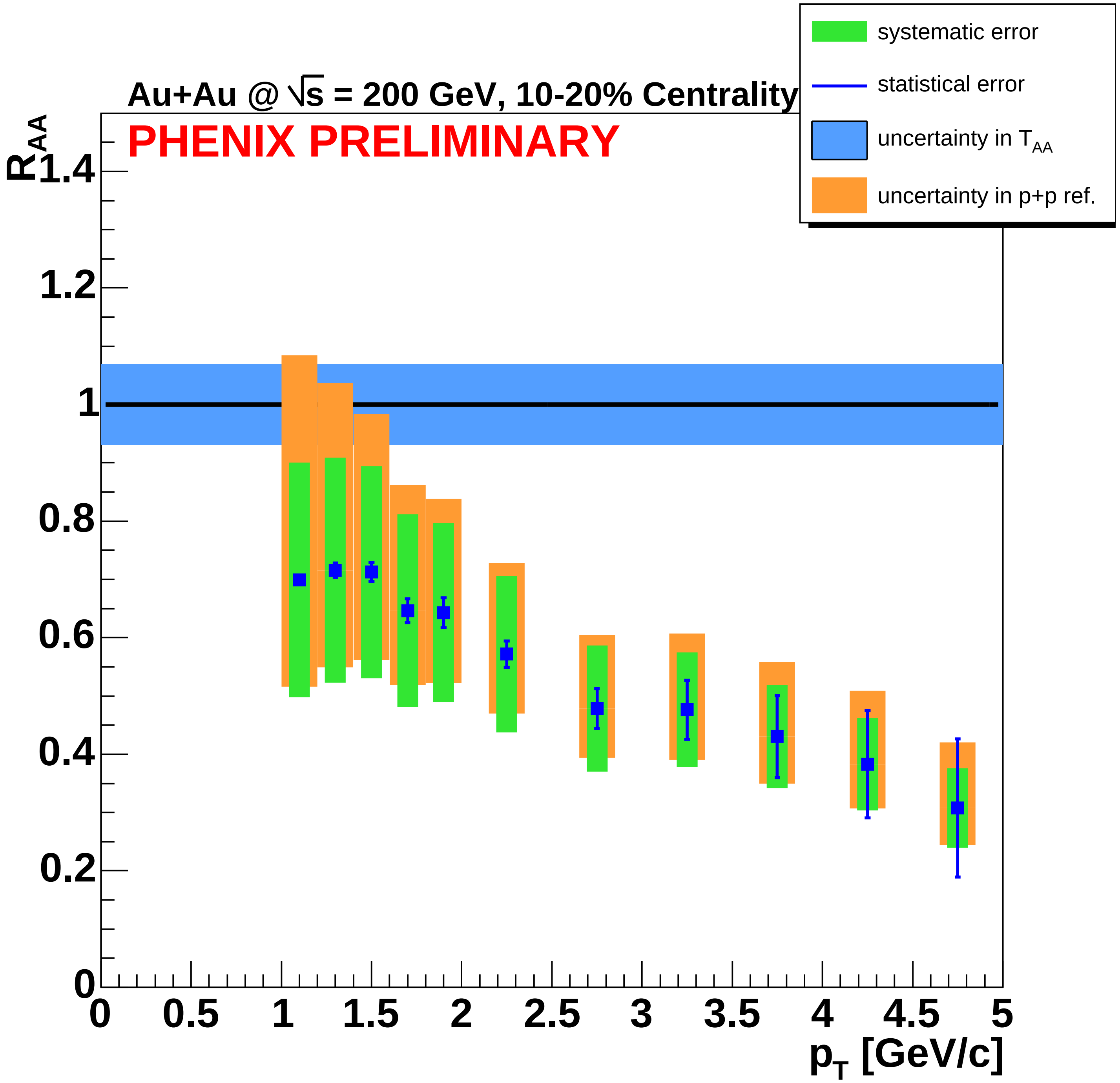
Au+Au @ √s = 200 GeV, 40-60% Centrality
PHENIX PRELIMINARY
R_{AA}
0
0.2
0.4
0.6
0.8
1
1.2
1.4
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
p_T [GeV/c]
systematic error
statistical error
uncertainty in T_{AA}
uncertainty in p+p ref.

R_{AA}



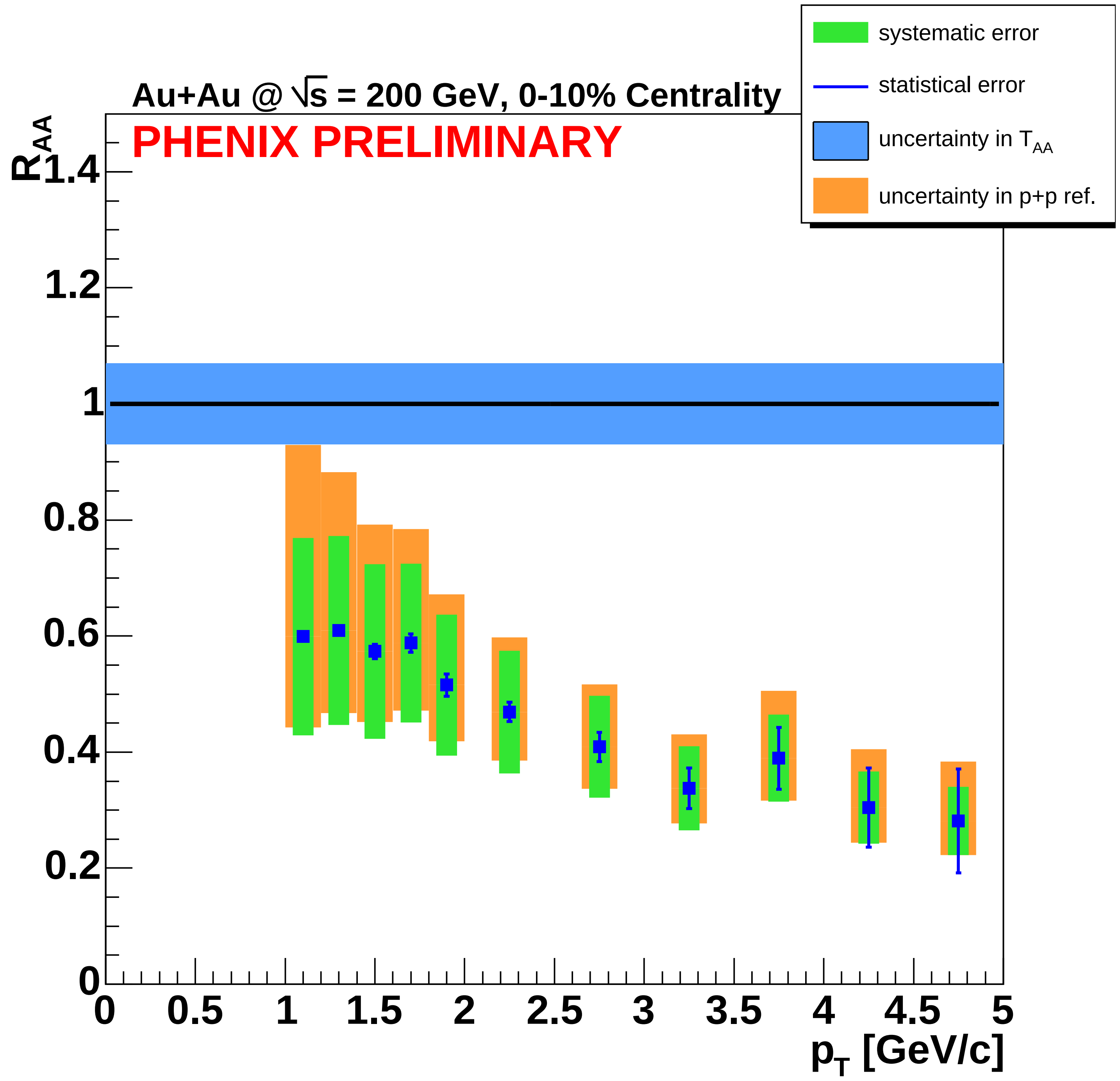
Au+Au @ √s = 200 GeV, 20-40% Centrality
PHENIX PRELIMINARY
systematic error
statistical error
uncertainty in T_AA
uncertainty in p+p ref.
R_AA
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
p_T [GeV/c]

R_{AA}



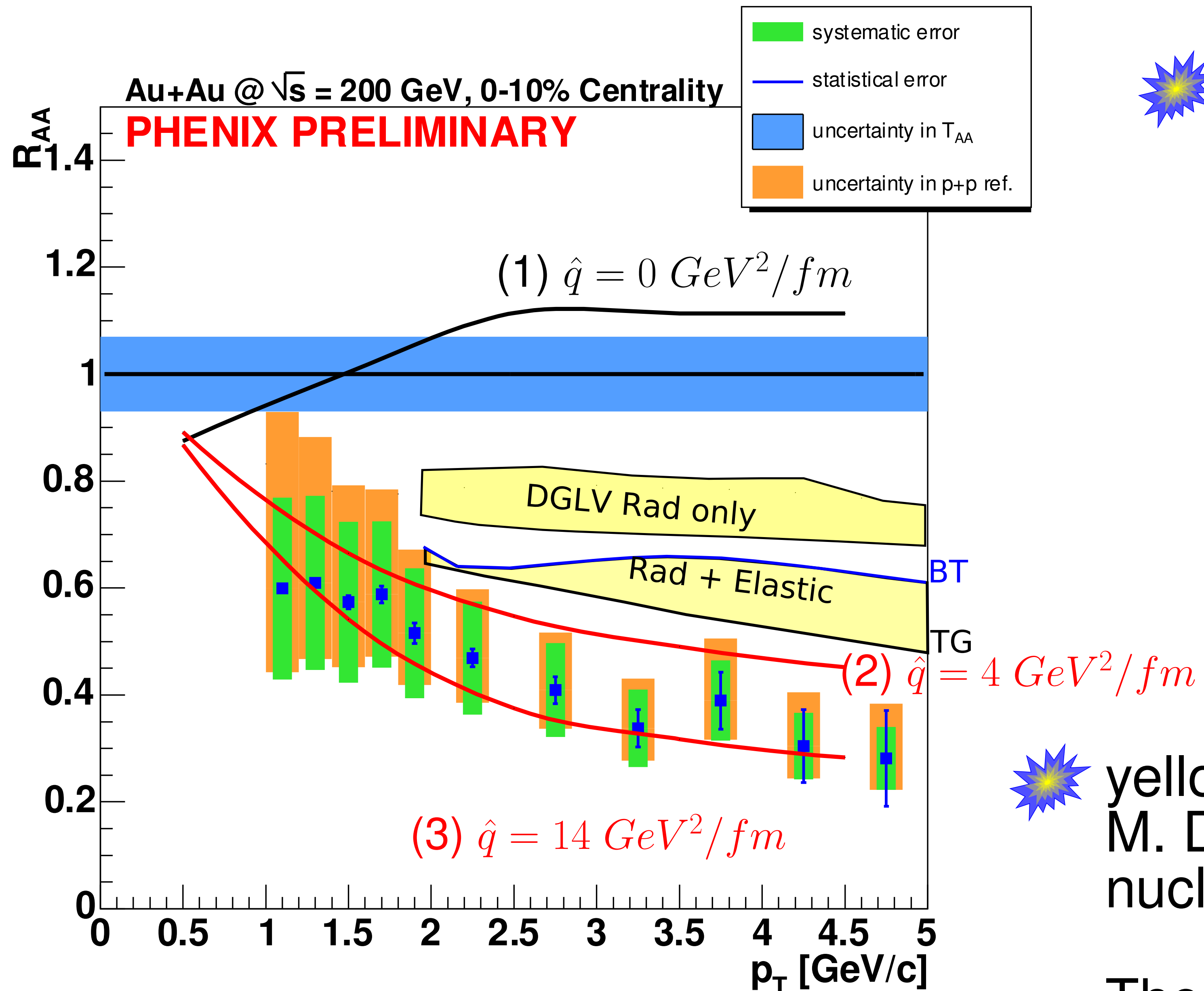
Au+Au @ √s = 200 GeV, 10-20% Centrality
PHENIX PRELIMINARY
systematic error
statistical error
uncertainty in T_AA
uncertainty in p+p ref.
R_AA
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
p_T [GeV/c]

R_{AA}



Au+Au @ √s = 200 GeV, 0-10% Centrality
PHENIX PRELIMINARY
systematic error
statistical error
uncertainty in T_AA
uncertainty in p+p ref.
R_AA
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
p_T [GeV/c]

Comparison to Theory



- (1) - (3): N Armesto, et al., PRD 71, 054027. only contains charm contribution

  $\hat{q} \equiv$ transport coefficient $\propto$ density of scattering centers in medium

- yellow bands: S. Wicks, W. Horowitz, M. Djordjevic, M. Gyulassy nucl-th/0512076

  The lower band contains elastic energy loss in addition to radiative energy loss

  $$\frac{dN_g}{dy} = 1000$$

Summary

- Electrons from heavy flavor decays in Au+Au collisions at $\sqrt{s}$ = 200 GeV/c have been measured at RHIC.
- Nuclear modification factor R_{AA} shows a strong suppression of the electrons from heavy flavor at high p_T
- R_{AA} favors models with large parton densities and strong coupling
- Contribution from bottom electrons does not affect the shape of R_{AA} as expected.